

WHAT IS CLAIMED IS:

- 1 1. An antenna comprising:
2 a first region having a first refractive index;
3 and
4 a second region having a negative refractive
5 index, said second region substantially surrounding
6 said first region, such that radiation outside said
7 second region is reproduced in said first region.

- 1 2. An antenna as defined in Claim 1, wherein said
2 first region has a positive refractive index.

- 1 3. An antenna as defined in Claim 1, wherein the
2 refractive index of said second region effectively
3 cancels out the optical properties of said first
4 region.

- 1 4. An antenna as defined in Claim 1, wherein said
2 first region comprises:
3 a first cylinder;
4 and wherein said second region comprises:
5 a second cylinder substantially surrounding said
6 first cylinder.

- 1 5. An antenna as defined in Claim 4, wherein the
2 length of said first cylinder and said second cylinder
3 is relatively long compared with the wavelength of
4 radiation to be reproduced in said first region.

- 1 6. An antenna as defined in Claim 4, wherein said
2 first cylinder has a radius of r_3 and wherein said
3 second cylinder has a radius of r_2 , and wherein the
4 refractive index n of said first cylinder is $n=r_2^2/r_3^2$.

- 1 7. An antenna as defined in Claim 4, wherein said
2 first cylinder has a radius of r_3 and said second

3 cylinder has a radius of r_2 , and wherein the
 4 electrical permittivity ϵ of said first and second
 5 cylinders are as follows:

$$\begin{aligned} \epsilon_x = +1, \quad \epsilon_y = +1, \quad \epsilon_z = +1, & \quad r > r_2 \\ \epsilon_x = -1, \quad \epsilon_y = -1, \quad \epsilon_z = -r_2^4/r^4, & \quad r_3 < r < r_2 \\ \epsilon_x = +1, \quad \epsilon_y = +1, \quad \epsilon_z = +r_2^4/r_3^4 = +r_1^2/r_3^2, & \quad r < r_3 \end{aligned}$$

7 the magnetic permeability μ being equal to the
 8 electrical permittivity ϵ .

1 8. An antenna as defined in Claim 4, wherein said
 2 first cylinder has a radius of r_3 and said second
 3 cylinder has a radius of r_2 , and wherein said antenna
 4 reproduces radiation in an area of radius r_1 outside
 5 said second cylinder, where $r_1 > r_2$, wherein $\frac{r_2^2}{r_3} = r_1$.

1 9. An antenna as defined in Claim 1, wherein said
 2 first region comprises:
 3 a sphere; and
 4 wherein said second region comprises:
 5 a second sphere substantially enclosing said
 6 first sphere.

1 10. An antenna as defined in Claim 9, wherein said
 2 first sphere has a radius of r_3 and wherein said
 3 second sphere has a radius of r_2 , and wherein the
 4 electrical permittivity ϵ of said first and second
 5 spheres are as follows:

$$\begin{aligned} \epsilon_x = \epsilon_y = \epsilon_z = +\frac{r_2^2}{r_3^2}, & \quad 0 < r < r_3 \\ \epsilon_x = \epsilon_y = \epsilon_z = -\frac{r_2^2}{r^2}, & \quad r_3 < r < r_2 \\ \epsilon_x = \epsilon_y = \epsilon_z = +1, & \quad r_2 < r < \infty \end{aligned}$$

7 and the magnetic permeability μ is equal to the
8 electrical permittivity ϵ .

1 11. An antenna as defined in Claim 1, wherein said
2 antenna comprises a narrow beam antenna.

1 12. A method of producing an antenna comprising:
2 providing a first region having a first
3 refractive index; and
4 providing a second region having a negative
5 refractive index, said second region substantially
6 surrounding said first region, such that radiation
7 outside said second region is reproduced in said first
8 region.

1 13. A method as defined in Claim 12, wherein said
2 first region has a positive refractive index.

1 14. A method as defined in Claim 12, wherein the
2 refractive index of said second region effectively
3 cancels out the optical properties of said first
4 region.

1 15. A method as defined in Claim 12, wherein said
2 providing said first region step comprises:
3 providing a first cylinder;
4 and wherein said providing said second region step
5 comprises:
6 providing a second cylinder substantially
7 surrounding said first cylinder.

1 16. A method as defined in Claim 12, wherein said
2 providing said first region step comprises:
3 providing a sphere; and
4 and wherein said providing said second region step
5 comprises:

6 providing a second sphere substantially enclosing
7 said first sphere.

1 17. A method as defined in Claim 12, wherein said
2 antenna comprises a narrow beam antenna.

1 18. A narrow beam antenna comprising:
2 a first region having a first refractive index
3 which is positive; and
4 a second region having a negative refractive
5 index, said second region substantially surrounding
6 said first region, such that radiation outside said
7 second region is reproduced in said first region,
8 wherein the refractive index of said second region
9 effectively cancels out the optical properties of said
10 first region.

1 19. A method as defined in Claim 18, wherein said
2 first region comprises:
3 a first cylinder;
4 and wherein said second region comprises:
5 a second cylinder substantially surrounding said
6 first cylinder.

1 20. A method as defined in Claim 18, wherein said
2 first region comprises:
3 a sphere; and
4 wherein said second region comprises:
5 a second sphere substantially enclosing said
6 first sphere.